This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

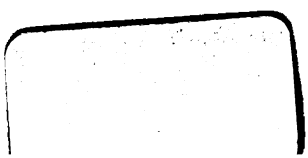
Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Digitized by Google

3 2044 106 386 238

LIBRARY OF SCIENCE
63.95
IOWA STATE COLLEGE AMES

S.P.



Digitized by Google

Digitized by Google

Digitized by Google

BULLETIN No. 27.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF BOTANY.

SEEDS OF COMMERCIAL SALTBUSHES.

BY

G. N. COLLINS.

LIBRARY OF
63
OAKES, N.D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

Digitized by Google

Digitized by Google

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF BOTANY,
Washington, D. C., March 20, 1901.

SIR: I have the honor to transmit herewith, for publication as Bulletin No. 27, a manuscript by Mr. G. N. Collins, of this Division, entitled Seeds of Commercial Saltbushes, prepared under the direction of Mr. A. J. Pieters, in charge of the Seed Laboratory. The great value of the saltbushes as forage plants for the alkaline soils of the West has brought the species of the genus Atriplex prominently into notice. The American seed trade has actively taken up the work of supplying the seeds of the economic species, and difficulty is often encountered in determining whether the seed secured is that of the species desired. The fruits of most of the species are so characteristic, however, that it is readily possible to recognize them from good photographs, and it has seemed advisable to publish descriptions and illustrations of authentic specimens of both fruits and seeds, in order that experiment station workers and seedsmen might have a reliable and convenient means of identifying the seeds.

Respectfully,

FREDERICK V. COVILLE,
Botanist.

Hon. JAMES WILSON,
Secretary of Agriculture.

Digitized by Google

Digitized by Google

CONTENTS.

	Page.
Introduction	9
Fruit characters	9
Seed characters	11
Fruit and seed characters by species	14
Atriplex holocarpa F. Mueller	14
Atriplex halimoides Lindl	14
Atriplex vesicaria Heward	16
Atriplex kochiana Maiden	16
Atriplex angulata Benth	18
Atriplex velutinella F. Mueller	18
Atriplex semibaccata R. Br	19
Atriplex leptocarpa F. Mueller	19
Atriplex nummularia Lindl	20
Atriplex confertifolia (Torr.) S. Wats	20
Atriplex parryi S. Wats	20
Atriplex pabularis Aven Nelson	22
Atriplex eremicola Osterhout	22
Atriplex truncata (Torr.) A. Gray	23
Atriplex expansa S. Wats	23
Atriplex canescens (Pursh) James	24
Atriplex nuttallii S. Wats	24
Atriplex argentea Nutt	26
Atriplex volutans Aven Nelson	26
Atriplex polycarpa (Torr.) S. Wats	26
Atriplex patula L	27
Atriplex hastata L	27
Atriplex hortensis L	28

Digitized by Google

Digitized by Google

ILLUSTRATIONS.

		Page.
PLATE I.—Fig. 1.	*Atriplex holocarpa* F. Mueller	14
Fig. 2.	*Atriplex halimoides* Lindl	14
II.—Fig. 1.	*Atriplex vesicaria* Heward	16
Fig. 2.	*Atriplex kochiana* Maiden	16
III.—Fig. 1.	*Atriplex angulata* Benth	18
Fig. 2.	*Atriplex velutinella* F. Mueller	18
Fig. 3.	*Atriplex semibaccata* R. Br	18
Fig. 4.	*Atriplex leptocarpa* F. Mueller	18
IV.—Fig. 1.	*Atriplex nummularia* Lindl	20
Fig. 2.	*Atriplex confertifolia* (Torr.) S. Wats	20
Fig. 3.	*Atriplex parryi* S. Wats	20
V.—Fig. 1.	*Atriplex pabularis* Aven Nelson	22
Fig. 2.	*Atriplex eremicola* Osterhout	22
Fig. 3.	*Atriplex truncata* (Torr.) A. Gray	22
Fig. 4.	*Atriplex expansa* S. Wats	22
VI.—Fig. 1.	*Atriplex canescens* (Pursh) James	24
Fig. 2.	*Atriplex nuttallii* S. Wats	24
VII.—Fig. 1.	*Atriplex argentea* Nutt	26
Fig. 2.	*Atriplex polycarpa* (Torr.) S. Wats	26
Fig. 3.	*Atriplex patula* L	26
Fig. 4.	*Atriplex hastata* L	26
VIII.—Fig. 1.	*Atriplex hortensis* L	28
Fig. 2.	*Atriplex hortensis* L	28
Fig. 3.	Representative seeds of Atriplex	28

Digitized by Google

Digitized by Google

SEEDS OF COMMERCIAL SALTBUSHES.

INTRODUCTION.

The increasing and already extensive use of saltbushes (*Atriplex* spp.) as forage plants in the arid regions of the West renders it desirable to provide some means of distinguishing the seeds of the various species now in use or likely to become of economic importance. Owing to the complicated and extremely variable character of the fruits of this group of plants, ordinary descriptive methods are quite inadequate for reliable diagnosis; and even with the assistance of comparative descriptions and photographs it may not always be possible to determine with certainty the species to which single seeds belong. But if a small series of seeds is available some idea of typical form can be reached and the species located with considerable certainty. The difficulty of accurately determining the species to which a seed belongs has been made vastly greater by the fact that in many cases two or more quite distinct forms have been included under one species. In such cases an effort has been made to figure the different forms, keeping their source distinct. Thus, in *A. nuttallii*, for example, there are at least three distinct forms which might well constitute as many species. No attempt has been made, however, to enter upon the much-needed revision of this genus, the present object being rather to figure and describe forms considered typical by those most familiar with these plants.

The subject is further complicated by the very anomalous manner in which most species bear their seed. The normal female flowers, with five-parted calyx, have been almost entirely replaced by flowers inclosed in various curiously formed bracts; and in these flowers the position of the seed has been changed from horizontal to vertical. The seed thus produced is again often differentiated into two distinct forms. In one section of the genus all three forms are to be found on a single plant.

FRUIT CHARACTERS.

What is commercially called the seed usually consists of the fruit inclosed in two bracts. The latter vary greatly in form and furnish the best characters for separating species. In some species, however,

Digitized by Google

where the seed is only loosely attached, it is usually found naked or covered only with the thin pericarp.

Except in the species belonging to the group Dichospermum, of which *A. hortensis* is the only one here described, the fruit of Atriplex is a one-seeded akene, having a very thin membranaceous pericarp, borne vertically between two bracts or prophylla. These may be thin and subfoliaceous in texture, in which case they are usually united only at the base, or they may be indurated and coalescent for a part of their length and variously ornamented with teeth, crests, or wings. In some of the Australian species they are spongy in texture and almost entirely coalescent.

In the group Dichospermum the fruit is borne in two totally different ways, vertically between two bracts, as in the other species, and horizontally, inclosed in a regular five-parted calyx.

Eichler[1] found that in the section Dichospermum only the female flowers inclosed in a normal calyx and producing horizontal seeds were a regular part of the florescence, those without calyx, but inclosed in prophyllar bracts and producing vertical seeds, occurring as adventitious sprouts.

In the section Teutliopsis, where only vertical seeds are produced, all the female flowers are adventitious, and here they are not always confined to the dichasium but 2 to 4 are frequently found below the inflorescence proper.

Concerning the homology of what are at present termed bracts or prophylla there has been much disagreement. Moquin (1840) based his belief that these organs were bracts and not sepals on two considerations: First, on their similarity to organs found in the genus Exomis, where one species, *E. albicans*, has organs apparently identical with those in Atriplex and in which there is also no trace of a perianth, while in *E. axyrioides* distinct traces of a calyx are to be found inside the bracts; secondly, on Fengl's statement that in monstrous flowers of Atriplex he found similar traces of a calyx. Wydler (1851) further strengthened this view by reporting the discovery, in *A. patula*, of fruiting branches borne in the axils of the organs in question.

Bentham (1870), apparently ignorant of Wydler's discovery, was led, after a careful study of the Australian species, to the belief that these organs are the true homologues of the male perianth, and on examination of the species of Exomis concluded that *E. albicans*, which so closely resembles some species of Atriplex, really belongs in that genus, while *E. axyrioides* is generically distinct, the bracts of the latter species having no homologue in Atriplex.

Most subsequent writers have followed Moquin and Wydler in considering these organs as bracts or prophylla. In preparing the present paper two American species, *A. polymorpha* and *A. nummularia*,

[1] Blüthendiagramme, vol. 2, p. 84, 1875.

Digitized by Google

as well as *A. patula*, were found frequently to produce fruits borne in the axils of the bracts, thus confirming Wydler's statement.

That these organs are bracts or prophylla, and not parts of a perianth, seems thus to be well established; for while branches might rarely appear as sports in the axils of sepals, the frequency of the occurrence of such branches in this group would seem to indicate that we are dealing with organs less specialized than true floral envelopes.

SEED CHARACTERS.

The seeds of Atriplex are of the type common in the Chenopodiaceae, more or less compressed and covered with a crustaceous testa, sometimes with a very thin inner integument. The embryo is campylotropous, coiled around the mealy albumen, the micropyle and hilum being very close together. The hilum, which is hardly to be distinguished in the mature seed, is connected with the base of the pericarp by a membranaceous funiculus which adheres closely to the seed.

The difficulty of adequately describing seeds of Atriplex is greatly increased by the fact that while in some species the seeds are all alike, there are in others two more or less well-marked forms, and in the group to which *A. hortensis* and related species belong there are three distinct types. In the species where there are three kinds of seed they may be characterized as follows:

(1) The seeds borne horizontally in a regular five-parted calyx. They are small, black, the sides convex, the tip of the radicle scarcely produced.

(2) The small, black seeds, resembling the first in appearance, but borne vertically between two bracts.

(3) The large, brown seeds, borne in the same manner as the second, but larger, light brown in color, the sides flattened, with a shallow groove near the margin, the tip of the radicle strongly produced.

In the species in which there are two forms of seeds these correspond to the second and third kinds described above. In some the difference is very marked, an intermediate form being rare, while in the others the distinction is difficult to maintain.

Except in the section Dichospermum, this differentiation of the vertical seeds into two forms seems to have been overlooked, although many Australian species and those belonging to the section Teutliopsis have two equally well-marked forms.

All the indigenous American species examined appear to produce but one kind; *patula*, *hastata*, and *rosea*, species producing two kinds of seed, belong to the European section Teutliopsis and occur in this country as introduced plants; *hortensis*, the only species found in America producing three kinds of seed, is also introduced. In some species

Digitized by Google

the available material contained very little well-formed seed, and in such cases it is of course impossible to say with certainty that only one form is produced.

This anomalous condition, where a single species produces seeds borne in two totally different ways and where those borne in one manner are again of two distinct forms, would seem to indicate an ecologic adaptation. If we consider the horizontal seeds to be the more primitive method, the production of adventitious vertical seeds may be looked upon as an adaptation of which the plant availed itself to secure other means of dissemination; for the loosely retained horizontal seeds would hardly be carried far from the parent plant, while the vertical seeds, inclosed as they are in bracts which are usually spongy and very light, or covered with irregular projections or wings, are admirably adapted for dissemination. For example, this class of fruits in *A. holocarpa*, with their spherical spongy or bladder-like bracts, would be rolled before the slightest breath of wind. The same result is accomplished in another way by *A. canescens*, in which the general form of the bracts is that of two thin circular plates interlocked, furnishing a spherical surface adapted to rolling and presenting the greatest possible surface to the wind.

That the vertical seeds are of greater importance to the species than the horizontal is indicated by the entire suppression of the latter in all but one section of the genus. An intermediate stage is said to exist in some species in which there appear abortive female flowers inclosed in a normal calyx, like that of the species producing horizontal seeds.

The further differentiation of the vertical seeds into two forms seems, however, entirely unnecessary, unless perhaps the brown seeds, with their softer covering, germinate more quickly than the others and thus enable the species to produce seedlings at two seasons, an arrangement which may be of great advantage in regions where the rainfall is deficient and uncertain.

The position of the seed in the pericarp varies in different species from that of having the tip of the radicle basal or near the point of attachment of the pericarp to that in which it is apical or close to the style.

There is considerable confusion in the way the terms relating to the position of the radicle have been used. Thus the term "lateral" has been applied to seeds in which the tip of the radicle is close to the point of attachment, but directed laterally; the same term has also been used to describe seeds in which the tip of the radicle is located midway between the base and apex, in which case it is of course ascending in direction. The same ambiguity obtains in regard to the other terms employed, such as "inferior," "ascending," and "superior," depending on whether location or direction is implied. To avoid this confusion it has seemed desirable in the following paper to adhere to the use of terms implying merely position. Thus, "basal" when

Digitized by Google

the point of the radicle or micropyle is close to the base of the pericarp, "apical" when close to the style, and "lateral" when midway between the two.

In the preparation of the following descriptions use was made of the collections of the Seed Laboratory, the Division of Agrostology, and the National Herbarium. Specimens were also kindly contributed by Aven Nelson, of the Wyoming Experiment Station.

Digitized by Google

FRUIT AND SEED CHARACTERS BY SPECIES.

ATRIPLEX HOLOCARPA F. Mueller.

(ANNUAL SALTBUSH.)

Fruiting bracts entirely coalesced, except the two very minute, closely appressed tips; 6 to 12 mm. long, 5 to 8 mm. in diameter; inflated; obovoid or spherical; interior spongy; external covering a delicate nearly white membrane with brown reticulations. If the seed is at all weathered this membrane entirely disappears, leaving the spongy skeleton exposed.

Seed retained in the bracts, borne near the center, showing a tendency toward dimorphism, some seeds being slightly broader, with the sides less convex, and with a more or less distinct marginal groove. The difference, however, is not well marked, intermediate forms being common. Seeds about 2 mm. long, 1.5 mm. wide. Radicle apical.

Pl. I, fig. 1.—Fruiting bracts, magnified 4 diameters.
Upper row, all dorsoventral views.
Lower row:
Left hand, a fruit with outer covering removed.
Middle, end view of apex.
Right hand, longitudinal section.

See also Pl. VIII, fig. 3.

Specimens taken from Seed Laboratory No. 27901, grown in the grass garden of the Division of Agrostology.

ATRIPLEX HALIMOIDES Lindl.

(GRAY OR MEALY SALTBUSH.)

Fruiting bracts entirely coalesced, except the two very minute, closely appressed tips; 3 to 9 mm. long, with the greatest diameter usually slightly exceeding the length; inflated; subhemispherical, the basal portion for the most part evenly rounded, the apex flat, concave, or convex, often with a raised margin, or forming a section of a cylinder, the axis at right angles to the bracts; interior spongy; outer covering a delicate membrane which disappears if the seed is exposed to the weather.

Seed retained in the bracts, borne near the center; two forms well marked, both nearly circular; the brown about 1.5 mm. in diameter and with a distinct marginal groove, the black about 1.25 mm. in diameter. No external differences could be observed in the fruiting bracts bearing the different kinds. Radicle basal.

Pl. I, fig. 2.—Fruiting bracts, magnified 4 diameters.
Upper row:
Left hand, slightly lateral, apical view.
Middle, lateral view.
Right hand, dorsoventral view.
Lower row:
Left hand, slightly apical, dorsoventral view.
Middle, appearance after exposure to weather.
Right hand, longitudinal section.

See also Pl. VIII, fig. 3.

Specimens taken from Seed Laboratory No. 9749, from Australia.

Digitized by Google

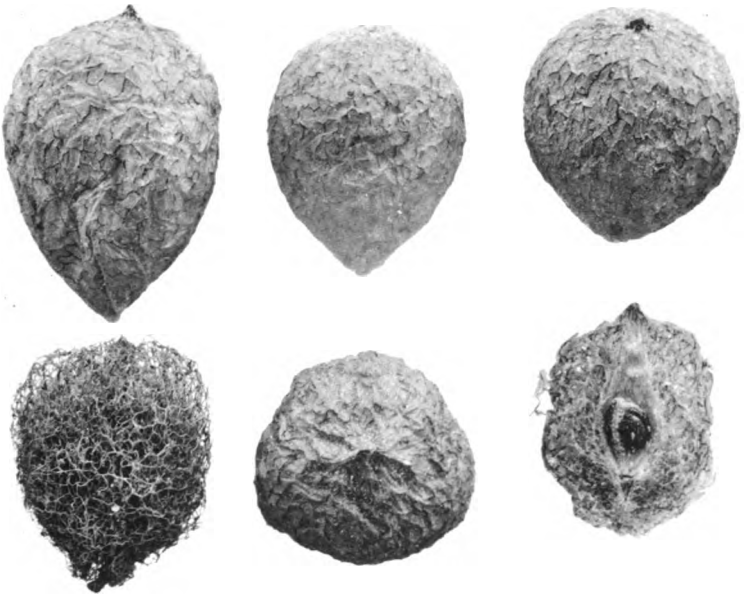


FIG. 1.—ATRIPLEX HOLOCARPA F. Muell.

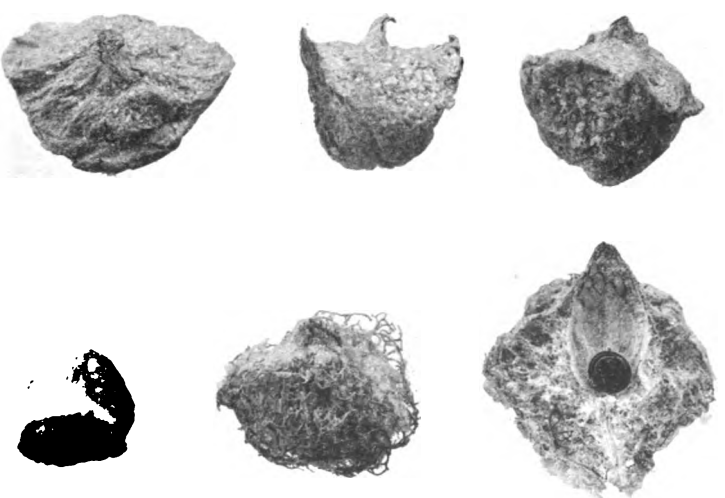


FIG. 2.—ATRIPLEX HALIMOIDES Lindl.

HELIOTYPE CO., BOSTON.

Digitized by Google

Digitized by Google

Digitized by Google

ATRIPLEX VESICARIA Heward.

(BLADDER SALTBUSH.)

Fruiting bracts united only at the base; 7 to 11 mm. long, slightly longer than broad; circular in general outline, with a blunt, stipe-like base; membranaceous; a bladder-like appendage borne on either side near the base, sometimes as long as the bracts themselves, but usually reaching about half way to the apex, frequently entirely wanting. This appendage collapses in drying into a crumpled mass of indefinite shape, making the whole appear very irregular, or if exposed to the weather it may break up, leaving only the sponge-like skeleton.

Seed retained in the bracts, borne near the base; the two forms quite distinct in color, but nearly uniform in size; 1.5 to 2.5 mm. in diameter. Radicle lateral or subapical.

Pl. II, fig. 1.—Fruiting bracts, magnified 4 diameters.

Right hand of lower row, lateral view; others all dorsoventral.

See also Pl. VIII, fig. 3.

Specimens taken from Seed Laboratory No. 32844, grown in California.

ATRIPLEX KOCHIANA Maiden.

(KOCH'S SALTBUSH.)

Fruiting bracts united at the base; 5 to 7 mm. long, 6 to 8 mm. broad; similar in structure to those of *A. vesicaria*, but broadly truncate, the length not more than half the width, and with the bladder-like appendages more regular, oval, and much longer, greatly exceeding the truncate apex.

Seed retained in the bracts, borne at the base; two forms, as in *A. vesicaria*, distinguishable only by color; 1.5 to 2 mm. in diameter. Radicle very prominent, subapical, slightly higher than in *A. vesicaria*.

Pl. II, fig. 2.—Fruiting bracts, magnified 4 diameters.

Upper row:

Right hand, lateral view.

Others, dorsoventral.

Lower row:

Right hand, longitudinal section.

Others, dorsoventral.

Specimens taken from Seed Laboratory No. 27757, from Australia.

Digitized by Google

FIG. 1.—ATRIPLEX VESICARIA Heward.

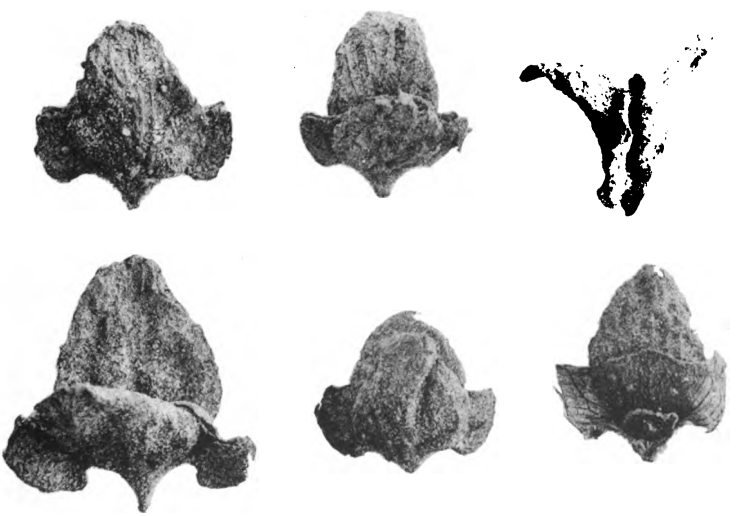


FIG. 2.—ATRIPLEX KOCHIANA Maiden.

HELIOTYPE CO., BOSTON.

Digitized by Google

Digitized by Google

Digitized by Google

ATRIPLEX ANGULATA Benth.

Fruiting bracts united below the seed; fan-shaped; 3 to 6 mm. long, 2.5 to 5 mm. broad; scaly-tomentose; the cylindrical stipe-like base 2 mm. in length, the free expanded apical portion closely appressed, the margin three to five angled; the dorsal bract slightly longer than the ventral, convex and plain, the ventral concave and bearing at the apex of the stipe two curved protuberances about 1.5 mm. long, their tips frequently touching, thus forming an arch.

Seed retained in the bracts, borne at the apex of the stipe; uniform; black; 1 to 1.5 mm. in diameter. Radicle prominent, subapical. Only one sample was available, and it is possible that the manner of gathering was such as in some way to exclude the second form.

Pl. III, fig. 1.—Fruiting bracts, magnified 4 diameters.

Upper row:
Right hand, lateral view.
Others, ventral views.

Lower row:
Left hand, dorsal view.
Right hand, longitudinal section.
Others, ventral views.

See also Pl. VIII, fig. 3.

Specimens from Seed Laboratory No. 27751, from Australia.

ATRIPLEX VELUTINELLA F. Mueller.

Fruiting bracts united only at the base; triangular in outline; nearly straight; an irregular spongy appendage at the base of each bract;[1] margins somewhat irregular, usually with one or two distinct teeth on each side of the more or less acuminate apex, rarely almost entire; surface scaly-tomentose, almost spongy.

Seed retained in the bracts, borne at the base; the two forms, though not differing much in size, are quite distinct in color, and the light seeds have a very distinct marginal groove; 1.25 to 1.5 mm. in diameter. The radicle, said by Bentham[2] to be either inferior or lateral, was found to be lateral or even subapical in all the fruit examined, agreeing with Mueller's figure.

Pl. III, fig. 2.—Fruiting bracts, magnified 4 diameters.

Upper row:
Left hand, longitudinal section.
Right hand, lateral view.

Middle row:
Right hand, ventral view.
Left hand, dorsal view.

Lower row, dorsal views.

Specimens taken from Seed Laboratory No. 27752, from Australia.

---

[1] Baron von Mueller (Icon. Aust. Salso. Plants, Pl. V, 1889) figures fruit in which these appendages are wanting.

[2] Flora Australiensis, vol. 5, p. 174, 1870.

Digitized by Google

FIG. 1.—ATRIPLEX ANGULATA Benth.

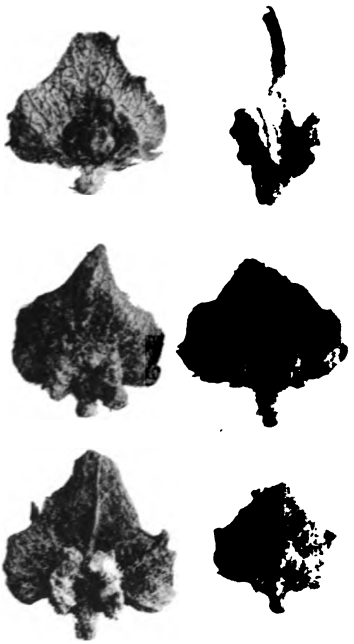


FIG. 2.—ATRIPLEX VELUTINELLA F. Muell.

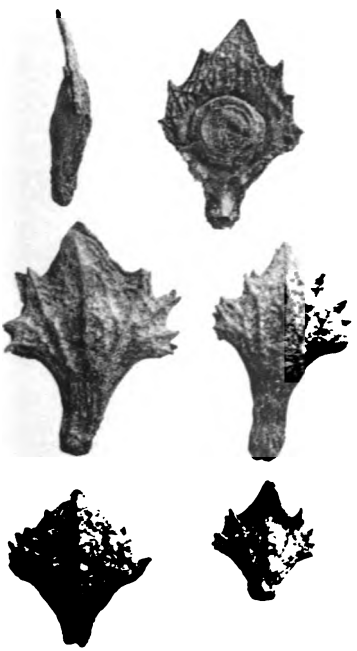


FIG. 3.—ATRIPLEX SEMIBACCATA R. Br.

FIG. 4.—ATRIPLEX LEPTOCARPA F. Muell.

HELIOTYPE CO., BOSTON.

Digitized by Google

Digitized by Google

ATRIPLEX SEMIBACCATA R. Br.

(AUSTRALIAN SALTBUSH.)

Fruiting bracts united for about one-half their length; 4 to 7.5 mm. long, 3 to 6 mm. wide; rhomboidal, with a more or less pronounced stipe-like base; compressed; scaly-tomentose; margins of the apical portion with 1 to 3 teeth on each side, rarely entire; dorsal and ventral surfaces without teeth or crests, three to five more or less prominent veins running from the base to the marginal teeth.

Seed retained in the bracts, borne near the center; two well-marked kinds; the black about 1.5 mm. in diameter, the brown about 2 mm. and with a distinct marginal groove. The black seed is usually borne in smaller fruiting bracts, having no well-defined stipe. Radicle lateral.

Pl. III, fig. 3.—Fruiting bracts, magnified 4 diameters.

Upper row:

Left hand, lateral view.

Right hand, longitudinal section.

Middle row, dorsoventral views.

Lower row, dorsoventral views.

The two bracts in the lower row are the form usually bearing black seed.

See also Pl. VIII, fig. 3.

Specimens taken from Seed Laboratory No. 16221, grown in California.

ATRIPLEX LEPTOCARPA F. Mueller.

(SLENDER SALTBUSH.)

Fruiting bracts entirely coalesced except at the apex; 5 to 10 mm. long, 1 to 1.5 mm. wide, with a slight enlargement at the middle over the seed, the apex slightly dilated and compressed; indurated; nearly smooth at the base, increasingly roughened toward the apex, the apical two-thirds obscurely furrowed longitudinally; without teeth or crests.

Seed retained in the bracts, borne near the middle; of two kinds, very distinct both in form and color; the black 1 to 2 mm. long, 0.75 to 1 mm. wide, the brown more compressed, much longer and narrower, the marginal groove indistinct. The brown seed is more often found in the long, slender bracts having a decided enlargement at the middle. See the first fruit in the figure. Radical apical.

Pl. III, fig. 4.—Fruiting bracts, magnified 4 diameters.

Upper row:

Left hand, dorsoventral view, bearing brown seed.

Others, dorsoventral views, bearing black seed.

Lower row, bearing black seed:

Second from left, lateral view.

Right hand, longitudinal section.

Others, dorsoventral views.

See also Pl. VIII, fig. 3.

Specimens taken from Seed Laboratory No. 32548.

Digitized by Google

ATRIPLEX NUMMULARIA Lindl.

(ROUND-LEAVED SALTBUSH.)

Fruiting bracts united only at the enlarged and slightly indurated base; 4 to 10 mm. in length, usually somewhat broader than long; circular in general outline; the free apical portion thin and closely appressed, the margins irregularly, sometimes obscurely, toothed, rarely entire, the delicate edge usually more or less broken; surface covered with a very fine scaly tomentum, the larger veins prominent. In some samples the bracts are thicker, more irregular, and rarely with one or more teeth on the dorsal or ventral surface.

Seed retained in the bracts, borne near the base. In the samples examined two forms of seed were not to be distinguished, all being more or less margined, with uniform gradations in size, and varying in color from light to dark brown; 1.5 to 2.5 mm. in diameter. Radicle subapical or apical.

Several specimens were found with a secondary fruit borne in the axil of a bract at the base of the pericarp; these fruits also inclosed in bracts, but in this species none containing well-formed seeds.

Pl. IV, fig. 1.—Fruiting bracts, magnified 4 diameters.

Upper row:

Right hand, lateral view.

Others, dorsoventral views.

Lower row:

Right hand, longitudinal section.

Others, dorsoventral views.

Specimens taken from Seed Laboratory No. 22554, from Australia.

ATRIPLEX CONFERTIFOLIA (Torr.) S. Wats.

(SPINY SALTBUSH.)

Fruiting bracts united only at the base; 4 to 8 mm. long, of about equal length and breadth; similar in form and structure to *A. nummularia*, but with the free apical portion not so closely appressed, and with the margins entire and less delicate.

Seed retained in the bracts, borne at the base; uniform; about 1.5 mm. in diameter. Radicle subapical.

In the samples examined very few perfect seeds were found.

Pl. IV, fig. 2.—Fruiting bracts, magnified 4 diameters.

Right hand of upper row, lateral view; others all dorsoventral.

Specimens taken from Seed Laboratory No. 14024, collected by J. B. Leiberg in Oregon.

ATRIPLEX PARRYI S. Wats.

(PARRY'S SALTBUSH.)

Fruiting bracts united, with a broad fissure across the apex; 2 to 4 mm. in length, usually somewhat wider than long; deltoid in general outline with the sides often broadly emarginate; margins entire or indistinctly dentate at the apex; the surface scaly-tomentose.

Seed retained in tlie bracts, borne near the base; very few well-formed seeds could be found, but all appeared to be of one form; light brown similar to those of *A. polycarpa*, but with a distinct marginal groove; about 1.5 mm. in diameter. Radicle prominent, subapical.

Pl. IV, fig. 3.—Fruiting bracts, magnified 4 diameters.

All dorsoventral views.

Specimens taken from Seed Laboratory No. 8730, collected by Frederick V. Coville in Lincoln County, Nev.

Digitized by Google

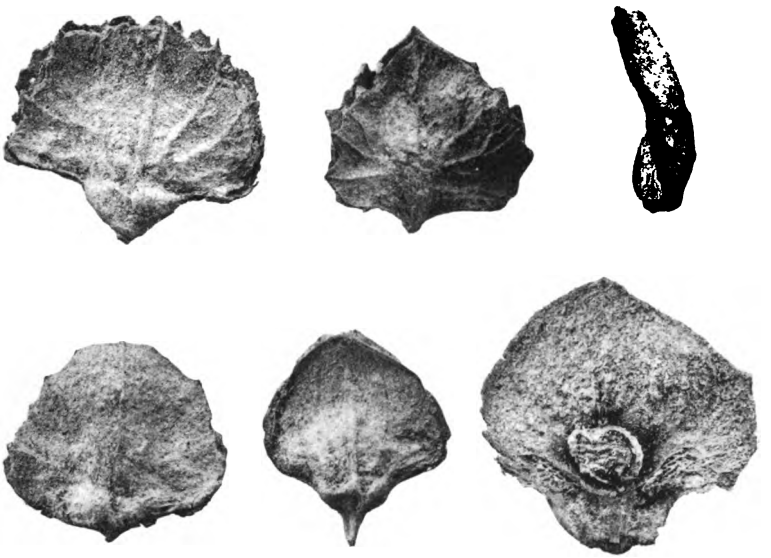


FIG. 1.—ATRIPLEX NUMMULARIA Lindl.

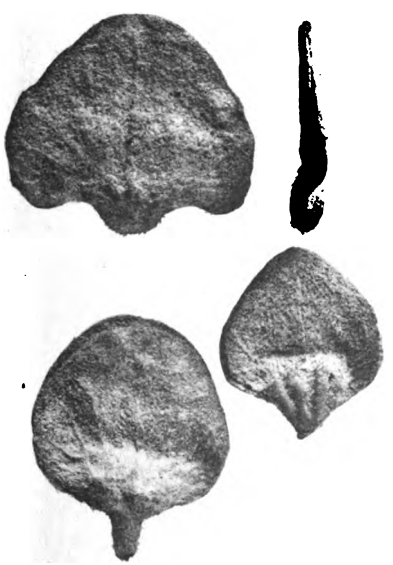


FIG. 2.—ATRIPLEX CONFERTIFOLIA (Torr.) S. Wats.

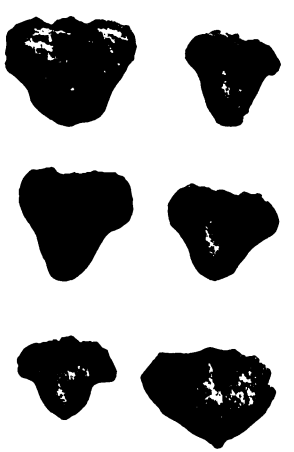


FIG. 3.—ATRIPLEX PARRYI S. Wats.

HELIOTYPE CO., BOSTON.

Digitized by Google

Digitized by Google

Digitized by Google

ATRIPLEX PABULARIS Aven Nelson.

(FORAGE SALTBUSH.)

Fruiting bracts united for a little more than half their length, 3 to 6 mm. long, usually slightly longer than wide; scaly-tomentose; rounded, thickened, and indurated at the base, the apex dentate with from one to eight teeth, one near the middle usually much longer than the others and frequently deflected from the plane in which they lie; dorsal and ventral surfaces frequently with one or more irregular teeth or crests, some reaching 1 mm. in length.

Seed retained in the bracts, borne at the base; uniform; nearly circular; brown, with a distinct marginal groove; 1.5 to 2.5 mm. in diameter. Radicle subapical, strongly produced and uncinate.

Pl. V, fig. 1.—Fruiting bracts, magnified 4 diameters.

Upper row:

Right hand, lateral view.

Others all dorsoventral.

See also Pl. VIII, fig. 3.

Specimens taken from Seed Laboratory No. 27902, collected by Aven Nelson in Wyoming.

ATRIPLEX EREMICOLA Osterhout.

(DESERT SALTBUSH.)

Fruiting bracts united almost to the apex; 4 to 7 mm. long, nearly twice as long as wide; rounded and thickened at the base, the lateral margins parallel or only slightly diverging; the apex 3-toothed, the median tooth usually longest, the lateral in some cases almost wanting; scaly-tomentose; dorsal and ventral surfaces usually plain, sometimes with one or two blunt teeth.

Seed retained in the bracts, borne at the base; uniform; rather dark brown, with only a trace of a marginal groove; 2 to 2.5 mm. long, 1.5 mm. wide. Radicle prominent, subapical.

This species can be distinguished from *A. pabularis* by the greater length of its bracts, as compared with the breadth, and their more nearly parallel sides. In this case also the seeds afford a good character, the radicle being straight in *A. eremicola* and uncinate in *A. pabularis*.

Specimens figured by Aven Nelson in Bulletin 42 of the Wyoming Experiment Station as *A. eremicola*, appear not to belong to that species, but to be more nearly related to *A. pabularis*, though probably quite distinct from either.

Pl. V, fig. 2.—Fruiting bracts, magnified 4 diameters.

Right hand of upper row, lateral view; others all dorsoventral.

See also Pl. VIII, fig. 3.

Upper and middle rows, specimens taken from Division of Agrostology, distribution No. 45, collected in Wyoming by E. Nelson.

Lower row, specimens contributed by Aven Nelson and identified by G. E. Osterhout.

Digitized by Google

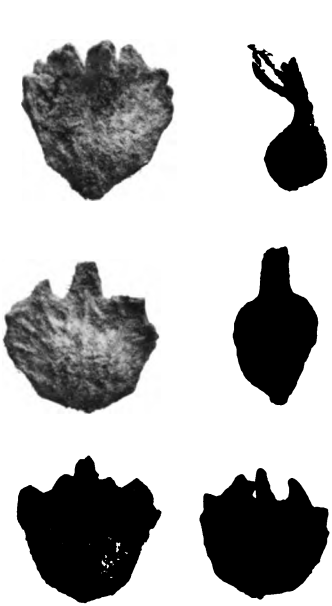


FIG. 1.—ATRIPLEX PABULARIS Aven Nelson.

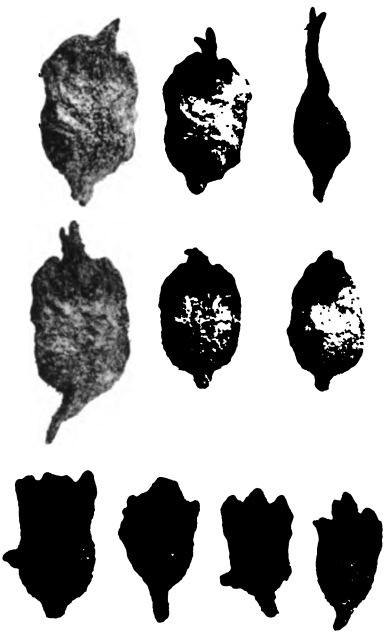


FIG. 2.—ATRIPLEX EREMICOLA Osterhout.

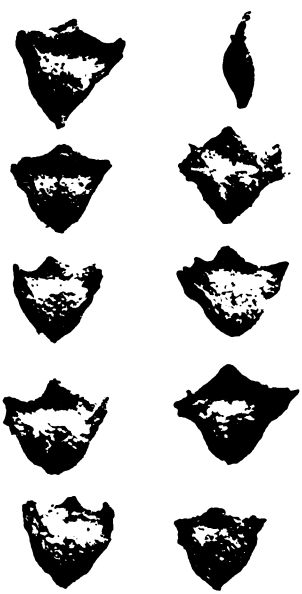


FIG. 3.—ATRIPLEX TRUNCATA (Torr.) A. Gray.

FIG. 4.—ATRIPLEX EXPANSA S. Wats.

HELIOTYPE CO., BOSTON.

Digitized by Google

Digitized by Google

ATRIPLEX TRUNCATA (Torr.) A. Gray.

(UTAH SALTBUSH.)

Fruiting bracts united almost to the apex; 2 to 5 mm. long, of about equal length and breadth; obdeltoid, the apex usually with three more or less distinct teeth, sometimes entire, or with more than three teeth; slightly indurated; scaly-tomentose; dorsal and ventral surfaces plain, or not infrequently bearing one or two blunt tubercles.

Seed retained in the bracts, borne at the base; uniform; light brown with a more or less pronounced marginal groove; 1 to 1.5 mm. in diameter; similar to *A. patularis* in form, but with the radicle more nearly straight. Radicle subapical.

Pl. V, fig. 3.—Fruiting bracts, magnified 4 diameters.

Right hand of upper row, lateral view; others all dorsoventral.

Specimens taken from the U. S. National Herbarium No. 285615, collected by Aven Nelson in Wyoming.

ATRIPLEX EXPANSA S. Wats.

Fruiting bracts entirely united or free at the apex; 3 to 6 mm. long, of al out equal length and breadth; suborbicular, raised on a short, broad, stipe-like base, the apical portion compressed; the margins, except at the base, coarsely dentate; dorsal and ventral surfaces scaly and granular, with prominent veins, plane or bearing numerous teeth or crests; slightly indurated about the seed, otherwise friable.

Seed retained in the bracts, borne at the apex of the short stipe; nearly circular; about 1.5 mm. in diameter. In the lighter-colored bracts the seed is lighter and suggests two forms, but this seems to be the only difference, and seeds intermediate in color are not uncommon. Radicle subapical.

Pl. V, fig. 4.—Fruiting bracts, magnified 4 diameters.

All dorsoventral views.

See also Pl. VIII, fig. 3.

Specimens taken from Seed Laboratory No. 4773, collected by S. B. Parish in southern California.

Digitized by Google

ATRIPLEX CANESCENS (Pursh) James.

(SHAD-SCALE.)

Fruiting bracts entirely coalesced; 5 to 15 mm. long, of equal length and breadth; consisting of a nearly spherical indurated center and four large, thin, semicular, membranaceous wings, with entire or gash-toothed margins, reaching from base to apex; nearly sessile or raised on a stipe often 5 mm. long; the surface in the smaller and perhaps younger fruit covered with a coarse scaly tomentum, in the specimens with larger bracts smoother, with the more prominent veins forming distinct reticulations.

Seed retained in the bracts, borne at the center; though variable, there appears to be but one form, rather dark brown, without marginal groove; about 2.25 mm. long, 1.5 mm. wide. Radicle apical.

Neither pair of wings represents the coalesced margin of the bracts, which, as indicated by the plane in which the seed lies, is between the wings.

In some specimens referred to this species teeth or crests are borne between the wings or even on their surface. This form is sometimes confused with *A. nuttallii*, but very unnecessarily, as in that species the bracts are not united at the apex.

Pl. VI, fig. 1.—Fruiting bracts, magnified 2 diameters.

Second from left of each row, apical view.

See also Pl. VIII, fig. 3.

Upper row, specimens taken from U. S. National Herbarium No. 25235, collected by F. H. Knowlton in Arizona.

Middle row, specimens taken from Seed Laboratory No. 3801, collected by J. W. Toumey at Tucson, Ariz.

Lower row, specimens taken from Division of Agrostology, distribution No. 1, collected by E. Nelson in Wyoming.

ATRIPLEX NUTTALLII S. Wats.

(NUTTALL'S SALTBUSH.)

Fruiting bracts united to near the apex; 5 to 10 mm. long, 3 to 10 mm. wide; very variable in form; covered with a very coarse scaly tomentum; nearly sessile or raised on a stipe often 4 mm. in length.

The most common form has the apex of the bracts divided into three teeth, the median usually longest, the sides and margins variously toothed and crested. A somewhat less common form has the median tooth more strongly developed, while the lateral are greatly reduced or wanting. This form usually has less pronounced crests.

Seed retained in the bracts, borne near the base; uniform; rather light brown, without marginal groove; 1.5 to 2 mm. in diameter. Radicle apical.

Another form, showing still greater variation from the usual type, is shown in the three fruits at the lower right hand of the figure. These were taken from No. 25236 in the National Herbarium, Watson's No. 981, cited by him in his original description as authentic material, but as it does not agree with his description it is possible that two forms were sent out under that number.

The more muricate forms of this species are sometimes difficult to distinguish from *A. argentea*. The most salient points of difference are the more membranaceous and friable character of the margins and teeth in the latter species, and the characteristic three-toothed apex in *A. nuttallii*. The more simple fruits with three-toothed apices might sometimes be confused with *A. pabularis* or *A. eremicola*, but the more pronounced stipe in *A. nuttallii* usually distinguishes it from these species.

Pl. VI, fig. 2.—Fruiting bracts, magnified 4 diameters.

Right hand of each row and third of lower row, lateral views; others all dorsoventral.

See also Pl. VIII, fig. 3.

Upper and middle rows, specimens from Division of Agrostology, distribution No. 3, collected by E. Nelson in Wyoming.

Lower row, left hand, three fruits from U. S. National Herbarium No. 290727; collected by Edward Palmer in Idaho; right hand, three fruits from U. S. National Herbarium No. 25236, collected by Watson in Nevada.

Digitized by Google

FIG. 1.—ATRIPLEX CANESCENS (Pursh) James.

FIG. 2.—ATRIPLEX NUTTALLII S. Wats.

HELIOTYPE CO., BOSTON.

Digitized by Google

Digitized by Google

Digitized by Google

ATRIPLEX ARGENTEA Nutt.

(SILVERY SALTBUSH).

Fruiting bracts united except at the very thin membranaceous margin; 4 to 8 mm. long, of about equal length and breadth; spheroidal or flattened; indurated; scaly-tomentose, almost spongy; sessile or raised on a blunt stipe-like base; margins undulate and gash-toothed; dorsal and ventral surfaces usually covered with large teeth or crests, often 2 to 3 mm. long, from which it is difficult to distinguish the marginal teeth. Both these and the marginal teeth are very friable and usually more or less broken.

Seed retained in the bracts, borne at the center; uniform; with a slight marginal groove; 1.5 to 2 mm. in diameter. Radicle prominent, apical or subapical.

The more simple bracts of this species sometimes quite closely resemble the more complex forms of *A. expansa*.

Pl. VII, fig. 1.—Fruiting bracts, magnified 4 diameters.

Right hand of upper row, lateral view; others dorsoventral.

Specimens taken from Seed Laboratory No. 34176, collected by T. A. Williams in Montana.

ATRIPLEX VOLUTANS Aven Nelson.

(TUMBLING SALTBUSH.)

The fruiting bracts and seed of this species are indistinguishable from those of *A. argentea*. The bracts have perhaps a slight tendency to be less complex, thus becoming intermediate between *argentea* and *expansa*.

ATRIPLEX POLYCARPA (Torr.) S. Wats.

Fruiting bracts united to near the apex, or more rarely nearly free; 3 to 7 mm. wide, one-third wider than long; broadly deltoid in general outline; the entire margin above the base deeply and finely gash-toothed, the teeth often over 2 mm. long; the dorsal and ventral surfaces commonly bearing numerous long slender teeth, which are frequently more or less united into crests; slightly indurated about the seed, otherwise very friable; surface scaly tomentose.

Seed retained in the bracts, borne at the center; uniform; from 1 to 1.5 mm. in diameter. Radicle apical.

In this species numerous instances were found where fruit was borne in the axils of the bracts at the base of the seed. In two instances fruit was found bearing two such secondary fruits inside the bracts. These fruits, together with the one in the axils of whose bracts they were found, all bore apparently normal seed.

Pl. VII, fig. 2.—Fruiting bracts, magnified 4 diameters.

Right hand of upper row, lateral view; others all dorsoventral.

See also Pl. VIII, fig. 3.

Specimens from Seed Laboratory No. 3807, collected at Tempe, Ariz., by J. W. Toumey.

Digitized by Google

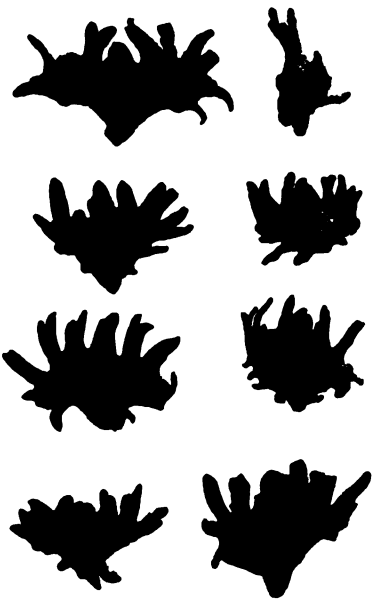


FIG. 2.—ATRIPLEX POLYCARPA (Torr.) S. Wats.

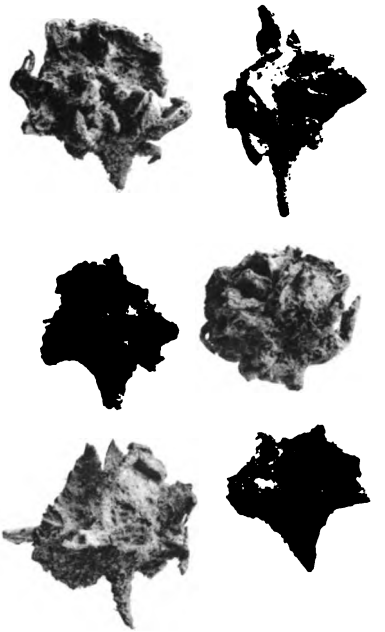


FIG. 1.—ATRIPLEX ARGENTEA Nutt.

FIG. 3.—ATRIPLEX PATULA L.

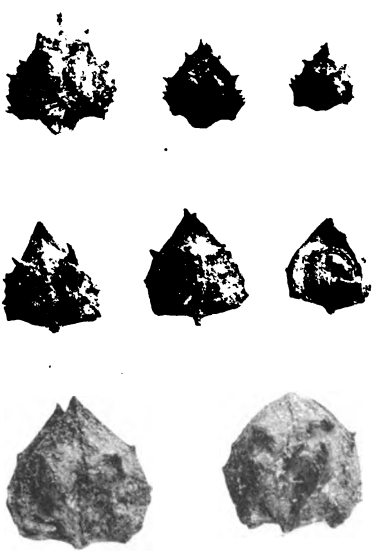


FIG. 4.—ATRIPLEX HASTATA L.

HELIOTYPE CO., BOSTON.

Digitized by Google

Digitized by Google

ATRIPLEX PATULA L.

Fruiting bracts united only at the base; 2 to 9 mm. long, usually one-third longer than wide; rhomboidal, subtriangular, or hastate in outline, the apex acute, the base abruptly narrowed, rarely truncate, the lateral angles more or less produced; margins entire; dorsal and ventral surfaces plane or rarely with one to four irregular projections; subfoliaceous in texture, the tips usually shrunken in the dried fruit, veins rather prominent.

Seed loosely retained in the bracts, borne at the base; of two kinds in every way like those of *A. hastata*. Radicle subbasal.

The more salient characters for separating the fruit of this species from *A. hastata*, from which it is sometimes scarcely to be distinguished, are its greater length in proportion to the breadth, the obtuse base, and the more foliaceous character of the bracts.

Pl. VII, fig. 3.—Fruiting bracts, magnified 4 diameters.

Right hand of upper row, lateral view; others all dorsoventral.

Specimens from U. S. National Herbarium No. 25233, collected by G. McCarthy in North Carolina.

ATRIPLEX HASTATA L.

Fruiting bracts united only at the base; 2 to 4 mm. long, of about equal length and breadth; triangular in outline, the apex in most cases abruptly acuminate, the base transverse, subcordate or very rarely slightly angled; the margins dentate or entire; dorsal and ventral surfaces normally with two rounded, often mucronate, prominences on each bract, frequently with other irregular projections, or smooth; membranaceous or slightly indurated and brittle.

Seed borne at the base of the bracts, of two kinds, very distinct both in form and color, both nearly circular; the black 1 to 1.5 mm. in diameter, the sides strongly convex; the brown, which appear to be less common, 1.5 to 2 mm., the sides flat or only slightly convex, the marginal groove in most cases quite distinct. Radicle subbasal.

The seed of this and related species is very loosely retained in the bracts and is frequently found naked as an impurity in commercial seed, when it is often difficult to determine the species. It is almost impossible to separate it from *A. patula*, and the only difference between the black seeds of this species and those of *A. hortensis* is the slightly smaller size in *A. hastata;* the brown seed can, however, be easily distinguished, that of *hastata* being smaller, with the sides more convex, the radicle much less produced, and the color a much darker brown. Furthermore, if the seed of *hortensis* is present in any quantity, some of the horizontal seeds of that species would likely be found. These can be recognized by the remains of the closely adhering pericarp, which shows the point of attachment to be on the side. From all other species likely to be found it can be separated by the low position of the radicle.

Pl. VII, fig. 4.—Fruiting bracts, magnified 4 diameters.

Upper row:

Dorsoventral views. Specimens from U. S. National Museum No. 282946, collected by E. H. Eames in Connecticut.

Middle row:

Right hand, longitudinal section.

Others, dorsoventral views. Specimens from U. S. National Herbarium No. 295718, collected by Frederick V. Coville at Ithaca, N. Y.

Lower row, dorsoventral views.

Specimens from U. S. National Herbarium No. 295716, collected by Frederick V. Coville at Ithaca, N. Y.

Digitized by Google

ATRIPLEX HORTENSIS L.

(GARDEN ORACHE.)

Fruiting bracts united only at the base; 3.5 to 8 mm. long, 3 to 7 mm. broad; ovate; thin, scarious, and very friable; margins entire; dorsal and ventral surfaces plain or with a slightly rounded elevation over the seed; veins prominent.

Seed of three kinds, the horizontal always found naked or covered only with the pericarp, the two kinds of vertical seeds very loosely retained in the bracts. The horizontal seed about 1.5 mm. in diameter; black; sides strongly convex. Radicle rounded, not at all produced. The black vertical seed borne between bracts, and corresponding to the black seed of the other species described, is slightly larger; nearly circular, with convex sides. Radicle subbasal, rounded and strongly produced. The yellow or brownish vertical seed also borne between bracts, and corresponding to the brown seed of other species; 3 to 3.5 mm. in diameter; nearly circular, the sides compressed or concave, with a very distinct marginal groove. Radicle subbasal, still more strongly produced, and more acute.

The seed of this species, as usually obtained, consists of the second and third kinds only, a smaller number of the horizontal seeds being produced, and these so insecurely attached in the widely spreading, 5-parted calyx that they seldom escape being shaken off. Thus the two forms of seed usually met with do not correspond to the two more frequently referred to in botanical works, where the vertical and horizontal types are mentioned, but no distinction is drawn between the two forms of vertical seeds.

Pl. VIII, fig. 1.—Fruiting bracts and horizontal fruit, magnified 4 diameters.
- Upper row:
  - Left-hand, dorsoventral view of bracts, bearing brown seed.
  - Right hand, same with one bract removed.
- Lower row:
  - Left hand, dorsoventral view of bracts bearing black seed.
  - Right hand, same with one bract removed.
- Center, horizontal fruit in calyx.

Specimens taken from U. S. National Herbarium No. 148809.

Pl. VIII, fig. 2.—Fruit and seed, magnified 6 diameters.
- Upper row—horizontal seeds:
  - Left hand, apical view of fruit.
  - Middle, basal view of fruit.
  - Right hand, seed, pericarp removed.
- Middle row—black, vertical seeds:
  - Left hand, lateral view of fruit.
  - Middle, opposite side of same.
  - Right hand, seed, pericarp removed.
- Lower row—brown, vertical seeds:
  - Left hand, lateral view of fruit.
  - Right hand, seed, pericarp removed.

Specimens taken from U. S. National Herbarium No. 148809.

Pl. VIII, fig. 3.—Seeds, magnified 6 diameters.
- *Atriplex holocarpa*, two kinds of seed, brown seed at the left.
- *Atriplex halimoides*, two kinds of seed, brown seed at the left.
- *Atriplex vesicaria*, two kinds of seed, brown seed at the left.
- *Atriplex leptocarpa*, two kinds of seed, brown seed at the left.
- *Atriplex semibaccata*, two kinds of seed, brown seed at the left.
- *Atriplex angulata*, one seed.
- *Atriplex hastata*, two kinds of seed, brown seed at the left.
- *Atriplex pabularis*, one seed.
- *Atriplex eremicola*, one seed.
- *Atriplex expansa*, one seed.
- *Atriplex canescens*, one seed.
- *Atriplex nuttallii*, one seed.
- *Atriplex polycarpa*, one seed.

Digitized by Google

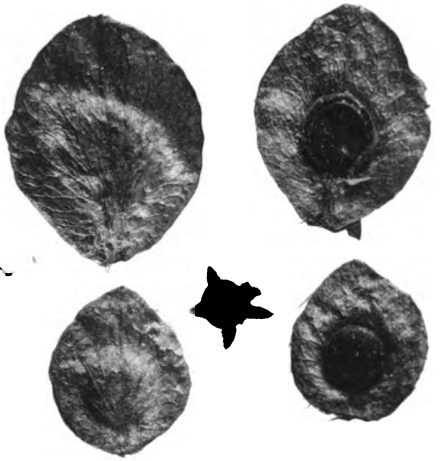


FIG. 1.—ATRIPLEX HORTENSIS L.

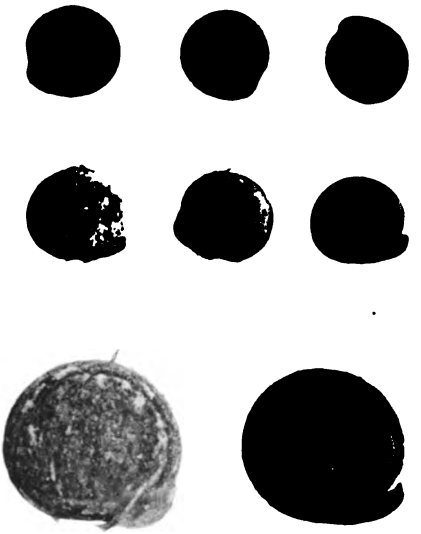


FIG. 2.—ATRIPLEX HORTENSIS L.

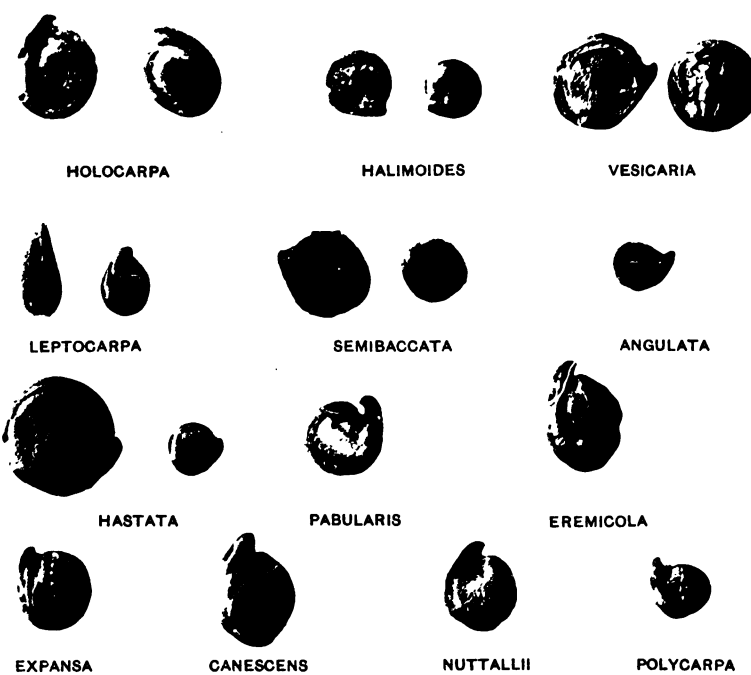


FIG. 3.—REPRESENTATIVE SEEDS OF ATRIPLEX.

HELIOTYPE CO., BOSTON.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Google